



Single Board Computers (SBC) in Ham Radio

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What are Single Board Computers (SBC)

- Small computers are like regular computers, however they have both a smaller physical size and “limited power draw” compared to regular computers such as a laptop or a desktop. Small computers may have additional features such as GPIO pins, which can be used to interface directly with hardware or electronics projects. Small computers also can be more cost effective depending on the project.

What are Single Board Computers (SBC)

- They also contain everything you need on a single board. Unlike large computers, they don't have the option to add additional hardware (so of more to come...). They cannot have additional memory added or graphics cards etc...

Why use Single Board Computers

- Physical size makes it great to permanently mount in a go box or fit into a go bag / backpack.
- They can be more power efficient which can be helpful in Emcomm or remote operations when battery power is limited
- Small Computers may be cheaper to purchase than their larger counterpart.

When to use Regular Computers

- You want to run multiple services such as FT-8, grid tracker, and a logger.
- You want to have a dedicated screen and battery backup (i.e. laptop)
- You will be connected to main power in your shack and would like something which is easier to work on and have better cooling characteristics.

Single Board Computer (SBC) Options

- Arduino <<https://en.wikipedia.org/wiki/Arduino>>
- Raspberry Pi <https://en.wikipedia.org/wiki/Raspberry_Pi>
- X86 Mini PC <https://en.wikipedia.org/wiki/Mini_PC>

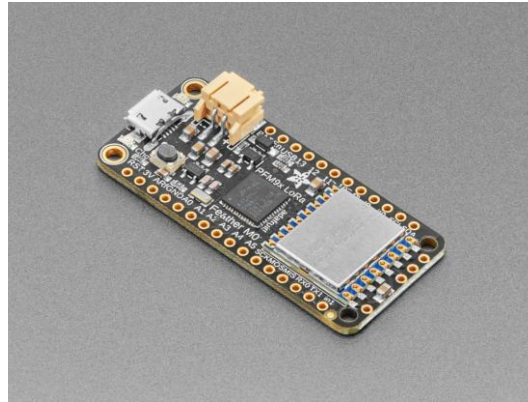
Arduino Family

- Arduino is a **microcontroller** and typically does not run an OS (operating system)
- Arduino boards have GPIO pins (more coming in the deck) and software programmable chips.
- They have no video output and require user defined logic to be written and flashed to the board.
- Used for more “advanced” electrical projects which requires sensors and digital monitoring of circuit states, etc...
- Very cost effective.
- Not a SBC because it is a microcontroller, share similarities with the SBC category.

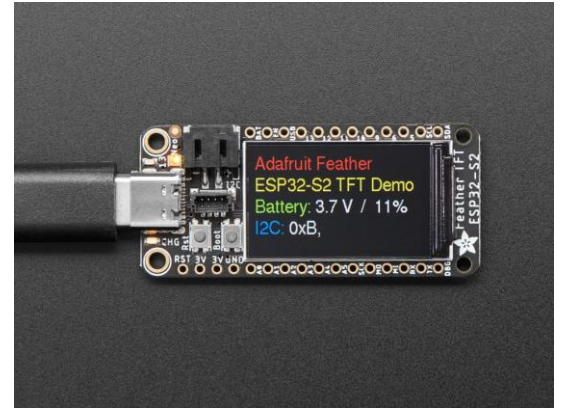
Arduino Examples



Basic Arduino UNO



Adafruit Feather
Has WiFi and
Bluetooth
Some have LoRa



Adafruit Feather
ESP32-S2
Contains a TFT
display

VERIFY/UPLOAD

SELECT BOARD & PORT

OPEN SERIAL MONITOR

AnalogReadSerial | Arduino IDE 2.0.0-rc9

Arduino MKR WiFi 1010

SKETCHBOOK

BOARD MANAGER

LIBRARY MANAGER

DEBUGGER

SEARCH

```
1  /*
2  AnalogReadSerial
3  Reads an analog input on pin 0, prints the result to the Serial Monitor.
4  Graphical representation is available using Serial Plotter (Tools > Serial Plotter menu).
5  An analog input pin of a potentiometer to pin A0, and the outside pins to +5V and ground.
6
7
8  This example code is in the public domain.
9
10 https://www.arduino.cc/en/Tutorial/BuiltInExamples/AnalogReadSerial
11 */
12
13 // the setup routine runs once when you press reset:
14 void setup() {
15   // initialize serial communication at 9600 bits per second:
16   Serial.begin(9600);
17 }
18
19 // the loop routine runs over and over again forever:
20 void loop() {
21   // read the input on analog pin 0:
22   int sensorValue = analogRead(A0);
23   // print out the value you read:
24   Serial.println(sensorValue);

```

OPEN SERIAL PLOTTER

Ham Radio Projects

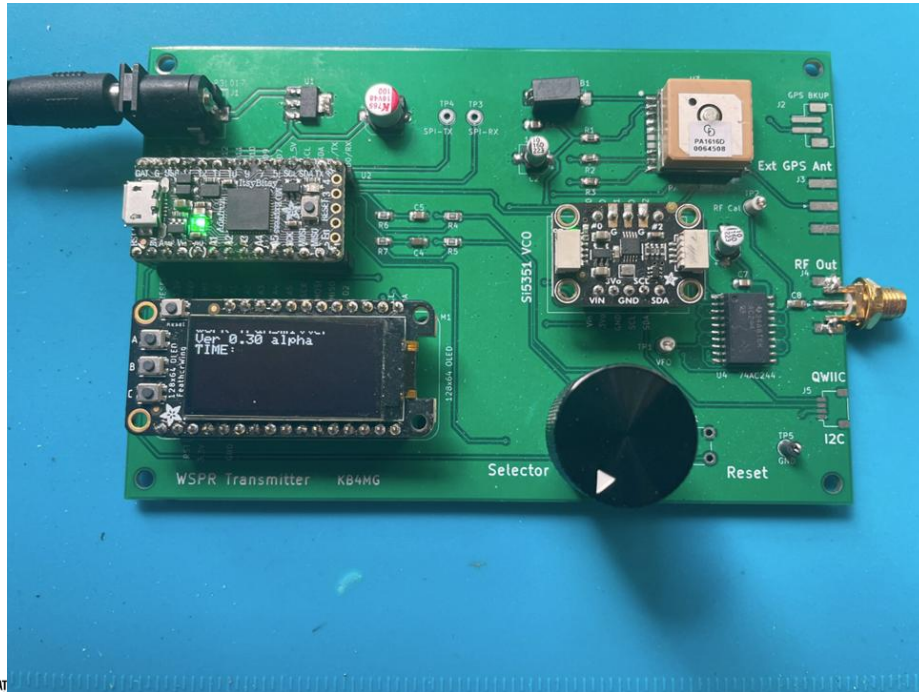
Easier Projects

- Station Power Monitor
- Remote COAX Switch
- GPS-based Network Time Server
- Rotor Controller
- Dummy Load with power meter

More Advanced Projects

- WSPR Transmitter
- SWR/Power Meter
- QRP transmitter
- Signal Generator
- Voice Memory Keyer
- CW Keyer
- Mag Loop Controller

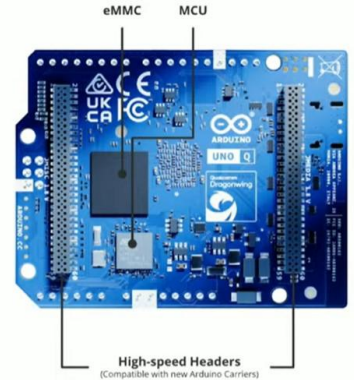
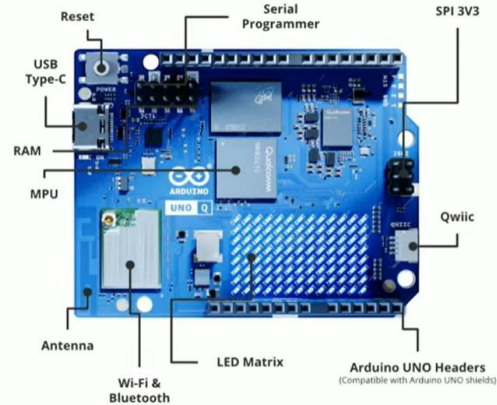
Example WSPR transmitter - KB4MG



- ❑ Arduino-based design
- ❑ Had GPS receiver for the accurate time base needed
- ❑ TFT Display for info and status
- ❑ Runs on 12v power

Future

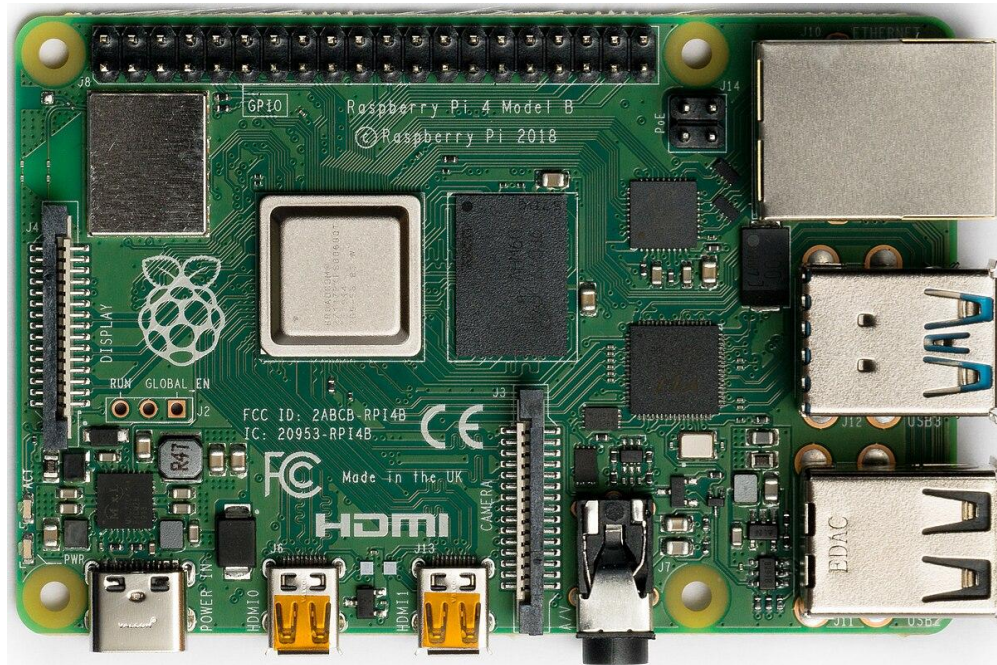
- ❑ Arduino is now part of Qualcomm (yes the cell phone chip guys)
- ❑ Newer version of Arduino will incorporate Qualcomm technology
 - ❑ Dragonwing QRB2210
- ❑ First product is called Arduino UNO-Q
- ❑ Extensive libraries for advanced applications that include AI/ML functions



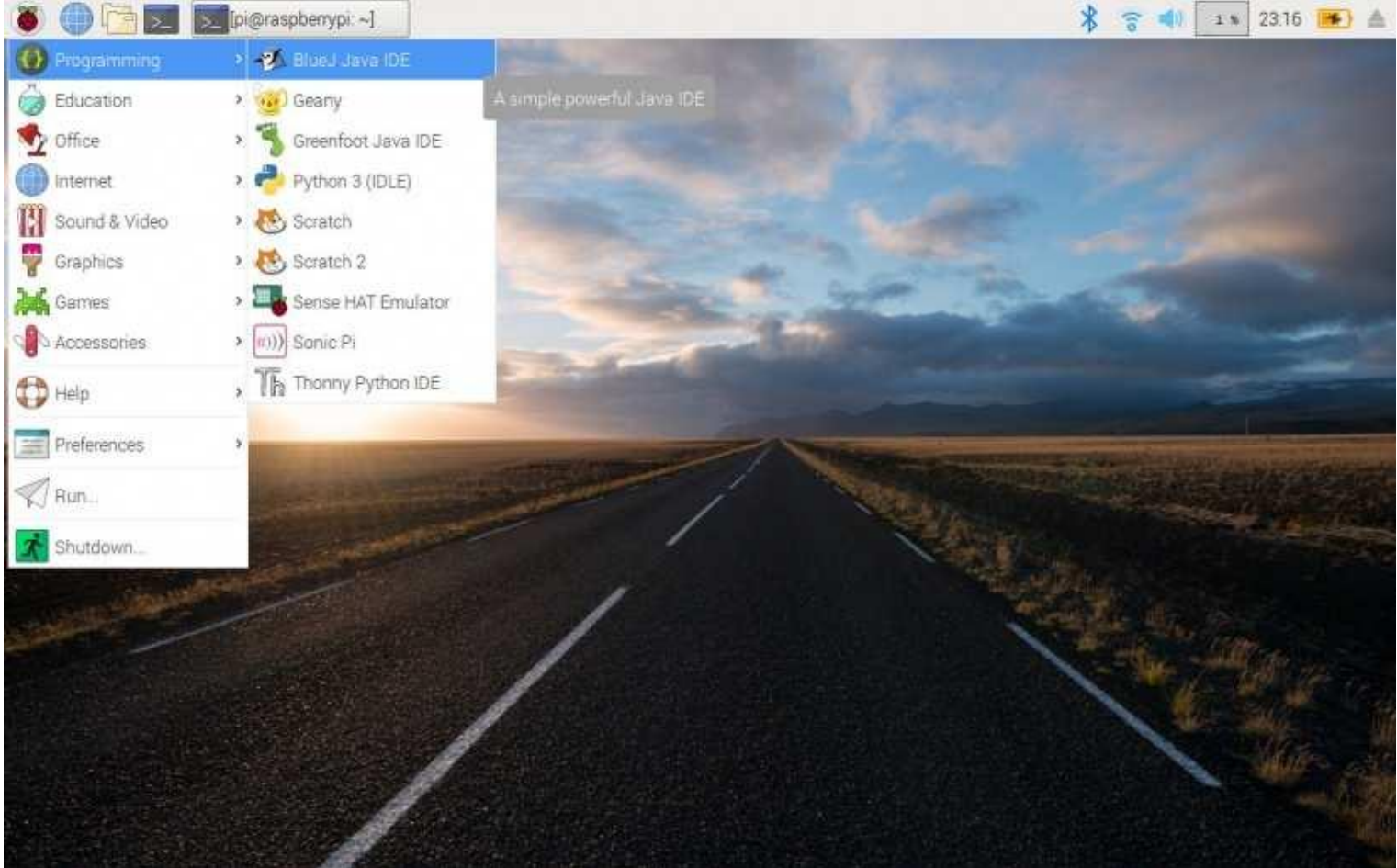
Raspberry Pi

- Raspberry Pis are boards which have GPIO pins (more coming in the deck) and however they also have usb ports for I/O, network, and video.
- They are a gateway between full computers a electrical projects.
- They run a complete operating system (web browser, notepad, etc..)
- Primarily runs Linux, so users will need to understand some console commands etc...
- NOTE: **Raspberry Pi Pico** is like the Arduino, it CANNOT run an operating system!!!! , but does run native Python

Raspberry Pi







Mini PC

- Mini PCs are boards which DO NOT have GPIO pins however they have many usb ports for I/O, network, and video.
- They are meant to run full computer services while in a small format.
- They run a complete operating system (web browser, notepad, etc..) and Windows based Apps (within reason, no CAD or COD)
- Mini PCs can run both Windows and Linux
- If you really wanted GPIO, pair it with an Arduino (stack or sandwich technology).















Mini PC



GPIO

- Stands for general purpose Input / Output which are pins used to connect to a programmable microcontroller
- Each pin has a different use. Some can be used for serial communication others can be used to send / read a voltage.
- Hats can be added to Arduinos and Raspberry PIs to build custom solutions (DMR Hotspot, WSPR transmitter, ????)
- Hats use a multitude of pins for many different things including inter-board communication.
- You can also use GPIO pins 1 by 1 and hardcode your own logic.

Raspberry Pi2 GPIO Header

| Pin# | NAME | | NAME | Pin# |
|------|------------------------------------|---|------------------------------------|------|
| 01 | 3.3v DC Power |  | DC Power 5v | 02 |
| 03 | GPIO02 (SDA1 , I ² C) |  | DC Power 5v | 04 |
| 05 | GPIO03 (SCL1 , I ² C) |  | Ground | 06 |
| 07 | GPIO04 (GPIO_GCLK) |  | (TXD0) GPIO14 | 08 |
| 09 | Ground |  | (RXD0) GPIO15 | 10 |
| 11 | GPIO17 (GPIO_GEN0) |  | (GPIO_GEN1) GPIO18 | 12 |
| 13 | GPIO27 (GPIO_GEN2) |  | Ground | 14 |
| 15 | GPIO22 (GPIO_GEN3) |  | (GPIO_GEN4) GPIO23 | 16 |
| 17 | 3.3v DC Power |  | (GPIO_GEN5) GPIO24 | 18 |
| 19 | GPIO10 (SPI_MOSI) |  | Ground | 20 |
| 21 | GPIO09 (SPI_MISO) |  | (GPIO_GEN6) GPIO25 | 22 |
| 23 | GPIO11 (SPI_CLK) |  | (SPI_CE0_N) GPIO08 | 24 |
| 25 | Ground |  | (SPI_CE1_N) GPIO07 | 26 |
| 27 | ID_SD (I ² C ID EEPROM) |  | (I ² C ID EEPROM) ID_SC | 28 |
| 29 | GPIO05 |  | Ground | 30 |
| 31 | GPIO06 |  | GPIO12 | 32 |
| 33 | GPIO13 |  | Ground | 34 |
| 35 | GPIO19 |  | GPIO16 | 36 |
| 37 | GPIO26 |  | GPIO20 | 38 |
| 39 | Ground |  | GPIO21 | 40 |

Early Models

Late Models

Rev 1
26/01/2014

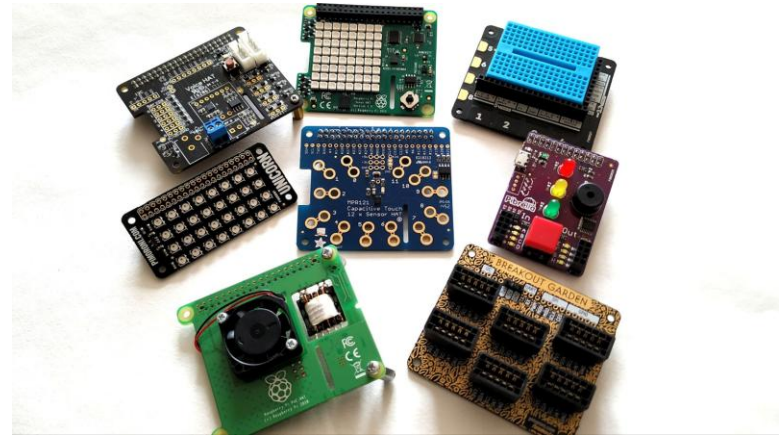
<http://www.element14.com>

More about the Raspberry Pi

- Can run without a video output (this is called headless)
- You can run many different linux services (Asterisk PBX or Webserver)
- Can run software such as hamclock
- You can even run WSJTX for FT-8 or PAT for Winlink (may run slow)
- Requires 5 volts (USB Voltage) to run (higher amps though @ 3 or more amps)

Raspberry Pi Hats

- This has all of the radio chips in the **hat** required to run an Allstar node.
- SDR transceiver **hat**, which turns your Raspberry Pi into a ham radio
- WSPR **hat** turns it into a WSPR transmitter
- You can run an Allstar node stand alone but there is also a **hat** called the Shari Pi Hat.







Raspberry Pi Project Ideas

- Offline wikipedia database - You can run an offline version of Wikipeida (or any other database for that matter) offline in the field. Run the Raspberry PI in headless mode and have a local Wifi network where users can join from their smartphones.
- Possibly serve up ARES docs and guides (Winter Field Day).
- Mount the PI in a go box and have the Wifi antennas drilled into the box, you could have an offline doc server fixed in your go box.

Raspberry Pi Project Ideas

- Offline wikipedia database - You can run an offline version of Wikipedia (or any other database for that matter) offline in the field. Run the Raspberry Pi in headless mode and have a local Wifi network where users can join from their smartphones.
- Check out <https://kiwix.org/en/applications/> they specialize on making backups of websites, documents, blogs, etc... for offline use
- Possibly serve up ARES docs and guides (Winter Field Day).
- Mount the PI in a go box and have the Wifi antennas drilled into the box, you could have an offline doc server fixed in your go box.

Raspberry Pi Project Ideas (cont.)

- D-RATs like web chat application with file sharing in a go box
- DMR Hotspot in a go box
- Allstart Hotspot in a go box
- Asterisk VoIP PBX (SIP Phones) phone system in a go box. Great for Emcomm, no license needed (would need network setup). Phones are easy for anyone to use (i.e. android softphones) private Hams Over IP service



Raspberry Pi Project Ideas (cont.)

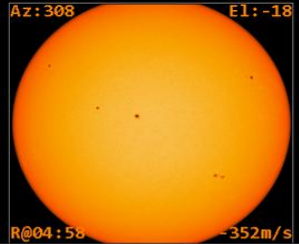
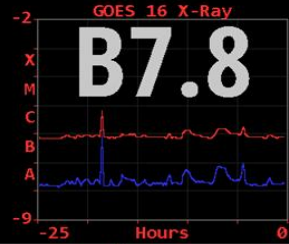
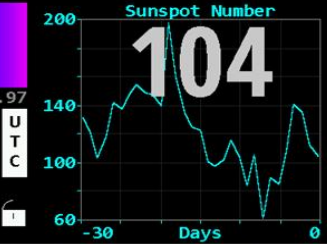
- Digital Mode Servers (PAT Winlink, JS-8-call, WSJT-X, APRS, Vara need to use WINE in Linux)
- SDR (Gnu Radio or SDR++ and a SDR dongle)
- Meshtastic Linux endpoint (Raspberry pi is actually pretty powerful in this setup)

K1FQL

Up 1m 49s IP 10.0.0.97 Ver 2.97

01:27²⁴

Sun Aug 20, 2023



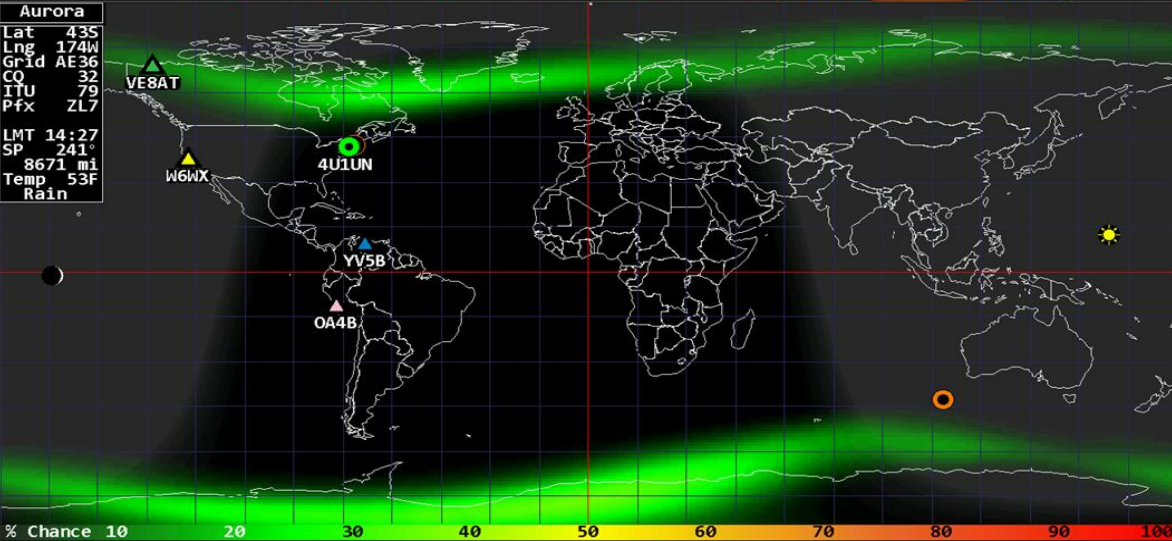
- NCDXF**
- ▲ 14.10
 - ▲ 18.11
 - ▲ 21.15
 - ▲ 24.93
 - ▲ 28.20

DE: ● UTC-5
 20:27 Aug 19
 43N 71W
 FN42 R in 8:31
 S 1:47 ago

DX: ○ UTC-5
 20:27 Aug 19
 42N 73W
 FN32 R in 8:39
 S 1:42 ago
 96i@238⁰_P

Aurora

| | |
|---------|-------|
| Lat | 43S |
| Lng | 174W |
| Grid | AE36 |
| CO | 32 |
| ITU | 79 |
| Pfx | ZL7 |
| LMT | 14:27 |
| SP | 241' |
| 8671 mi | |
| Temp | 53F |
| Rain | |



Raspberry Pi Project Ideas (cont.)

- You can install 73 Linux from KM4ACK. This is a script built for both Raspberry PI and x86 which installs a ton of ham radio software.
- What ideas do you have on what you would build?

Some comments on Linux

- Distributions are different based on a couple of things (i.e. the sysinit such as systemd vs OpenRC), the package manager (.deb vs RPM), and the desktop manager (usually this is flexible)
- Raspberry PI OS (Raspbian) is based off of debian Linux. It uses .deb packages to install software

Some comments on Linux

- Keep your linux system up to date by running (apt-get update) followed by (apt-get dist-upgrade)
- Take some time to learn console commands, they have super helpful (ls, pwd, cd, grep, etc...)
- Linux can be frustrating and “low level”, that is part of why it can run on the Raspberry PI so well.